REMARKS

In response to the Official Action mailed August 26, 2004, Applicants amend their application and request reconsideration. In this Amendment, no claims are added or canceled so that claims 1-5 remain pending. No new matter has been added.

Claim 1 is amended to recite "thermal functional designs" instead of "structural functional designs," in accordance with page 5, lines 9-14 of the patent application. Claim 1 is further amended to include a colon to separate the preamble from the body of the claim, in response to the objection in the Official Action. Claim 3 is amended to correct an antecedent basis issue.

The Official Action objects to claims 1-5 under 35 U.S.C. § 112, first paragraph, as reciting subject matter not enabled by the specification. That rejection is respectfully traversed.

The Official Action contends that the following limitations are not enabled by the specification:

- "supplying the computer information from databases relating to biomechanical and structural characteristics of a human body and structural and mechanical characteristics of chosen textile materials for computational simulation of the information"
- "creating visual images for the monitor showing modules of structural functional designs."

Applicants submit, however, that one of ordinary skill in the art of modeling the mechanics of human/textile interaction would have been sufficiently enabled by the disclosure of the patent application to practice the invention claimed. In support of Applicants' contention, a copy of the paper entitled "Advanced Computing Technology for Integrated Design of Textiles and Apparel" by Y. Li (hereinafter, the Li paper) is attached to this Response. The Li paper is incorporated by reference in the patent application and, therefore, is part of the disclosure. See page 4, lines 11-14 of the patent application. This publication demonstrates that one of ordinary skill in the art was enabled to model biomechanical characteristics or textile mechanic characteristics individually at the time of the filing of the present patent application. The present invention teaches the integration of physiological modeling and the mechanical modeling of textiles into a single methodology creating thermal functional designs of clothing (see page 4, line 25 to page 5, line 14 and Figure 2 of the patent application). Accordingly, one of ordinary skill in the art was certainly enabled to practice the claimed invention at the time of the filing of the present patent application, based on the present patent application and knowledge in the relevant arts. Therefore, the enablement rejection should be withdrawn.

The Official Action rejects claims 1-5 as anticipated by Lennon (US Patent 6,624,843). That rejection is respectfully traversed.

Contrary to the assertion of the Official Action, Lennon fails to teach all of the limitations of claim 1. Namely, Lennon fails to disclose information relating to "structural mechanical characteristics of chosen textile materials." Lennon merely discloses storing information about garment style, size, and body type (see column 5, lines 55-62 of Lennon). Lennon does not use information relating to mechanical characteristics of the selected textile materials in creating thermal functional designs of clothing.

Moreover, Lennon fails to teach all of the limitations of claim 1 as amended. That is, Lennon does not teach creating visual images of **thermal** functional designs of textiles. Thus, Lennon fails to teach all of the limitations of claim 1. Accordingly, Lennon cannot anticipate any pending claim so that the rejection of amended claim 1 and its dependent claims 2-5 is erroneous and should be withdrawn.

Reconsideration and withdrawal of the rejections, along with prompt allowance of the pending claims, are appropriate and earnestly solicited.

Respectfully submitted,

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Date: Nov. 24, 2004
AWF:tps

NR 2000:8

Ergonomics of Protective Clothing

Proceedings of NOKOBETEF 6 and
1st European Conference on Protective Clothing
held in Stockholm, Sweden, May 7–10, 2000

Kalev Kuklane and Ingvar Holmér (eds.)

ARBETE OCH HÄLSA VETENSKAPLIG SKRIFTSERIE

Arbetslivsinstitutet
National Institute for Working Life

This is one of the articles in "Ergonomics of Protective Clothing ~ Proceedings May 7-10, 2000."

Advanced Computing Technology for Integrated Design of Textiles and Apparel

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1. Clothing Consumption Trends

Extensive consumer research has shown that modern consumers require clothing to not only look good, but also feel good in dynamic wear situations. The comfort and superior functional performance of clothing have been identified as the most important attributes demanded by modern consumers, especially under dynamic wear situations (Figure 1). It has been noted that sports buffs are focusing on functional products and classic style as fashion is now of secondary importance. A recent survey in the US showed that 81% of US consumers signaled comfort as their top choice (Hong Kong TDC, 1999). In China, consumers ranked comfort in the top three most important attributes of apparel product. Therefore, comfort and functional performance have become a major focal point for manufacturers to gain competitive advantages in global apparel markets.

Over years of research, it has been found that clothing comfort consists of three major sensory factors: thermal-moisture comfort, tactile comfort and pressure comfort, as shown in Figure 2. The three sensory factors contribute up to 90% of overall comfort perceptions, and the relative importance of individual factors varies with different wear conditions. For active sportswear, thermal-moisture comfort is the most important factor, followed by tactile comfort and pressure comfort. Thermal-moisture comfort is determined by the heat and moisture transfer behaviour of clothing during dynamic interactions with human body and external environment. Tactile and pressure comfort is related to the mechanical behaviour of clothing during wear. Therefore, heat and moisture transfer and the mechanical behaviour of clothing materials are the two major dimensions in determining the comfort and functional performance of apparel products.

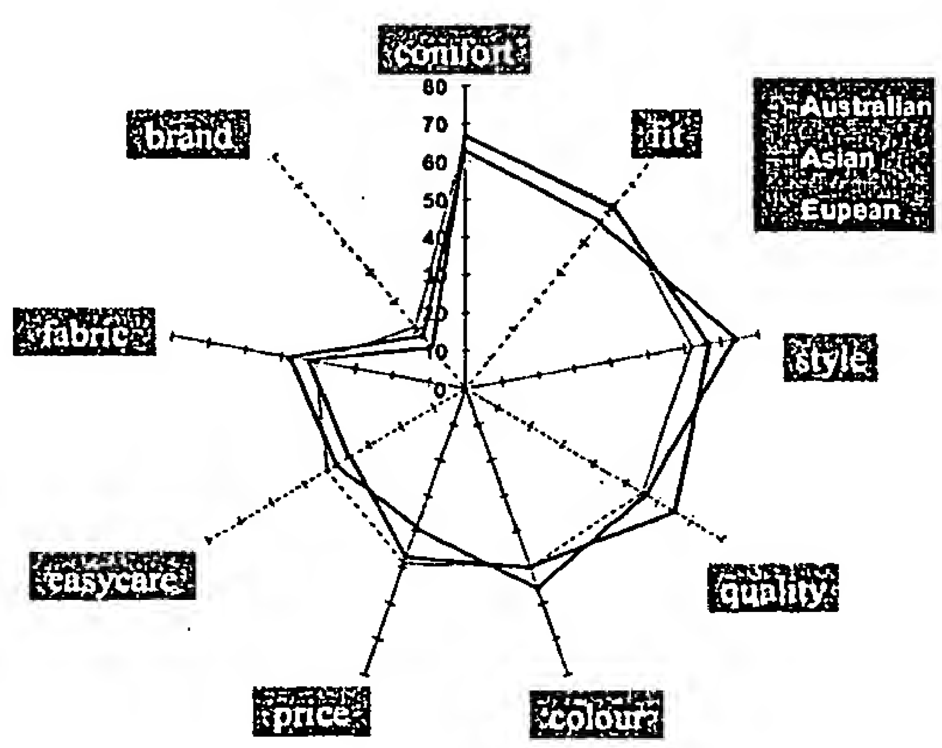

Figure 1 Clothing attribute requirements of modern consumers

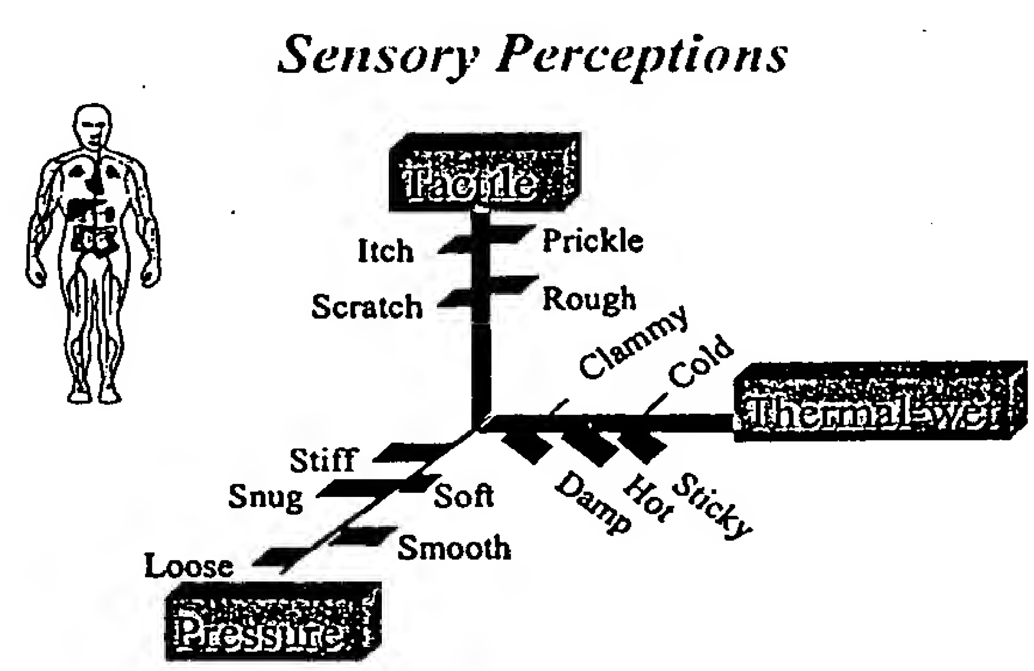

Figure 2 Sensory comfort of apparel products

Computer technology has successfully been used in the textile and apparel industries, and CAD techniques are widely used for fashion and textile design. The main purpose behind the utilization

of CAD is to increase productivity and flexibility during clothing fashion design process. As modern consumers demand personal comfort, CAD for fashion design alone cannot satisfy the needs of manufacturers to develop functional and comfortable products that can meet the requirements of consumers. However, CAD for clothing functional design has not been developed and applied in fashion industry. One of the major reasons is that the heat and moisture transfer and the mechanical behavior of textiles and clothing are extremely complex. Sound scientific understanding and mathematical simulation of the coupled heat and moisture and fabric mechanical behavior are essential requirements for developing advanced cyber technologies for the integrated design of apparel and textiles.

2. CAD for Fashion Design

Obviously, fashionable outlook of clothing is a major attribute that influences the psychological comfort and satisfaction, as well as the purchase decision of consumers. There are a number of dimensions in fashion design such as colour, texture, pattern, appearance (including drape), style and fit. Colour, texture and pattern are important components of artistic creativity during design processes, which have been enhanced successfully by CAD technology for textile design and directly linked to printing and dyeing processes. Commercial technological packages including software and hardware have been developed and applied successfully in fashion industry. Apparel appearance and drape is more difficult to be simulated and visualized by computing technology alone, as it is determined largely by the mechanical behaviour of clothing materials and its dynamic interaction with the body and external mechanical forces such as air movement. There is some CAD packages providing artificial simulations by computing image manipulations without considering the mechanical behaviour of clothing materials. Extensive research activities have been carried out around the world to develop numerical simulation of the drape effect on basis of fabric mechanics.

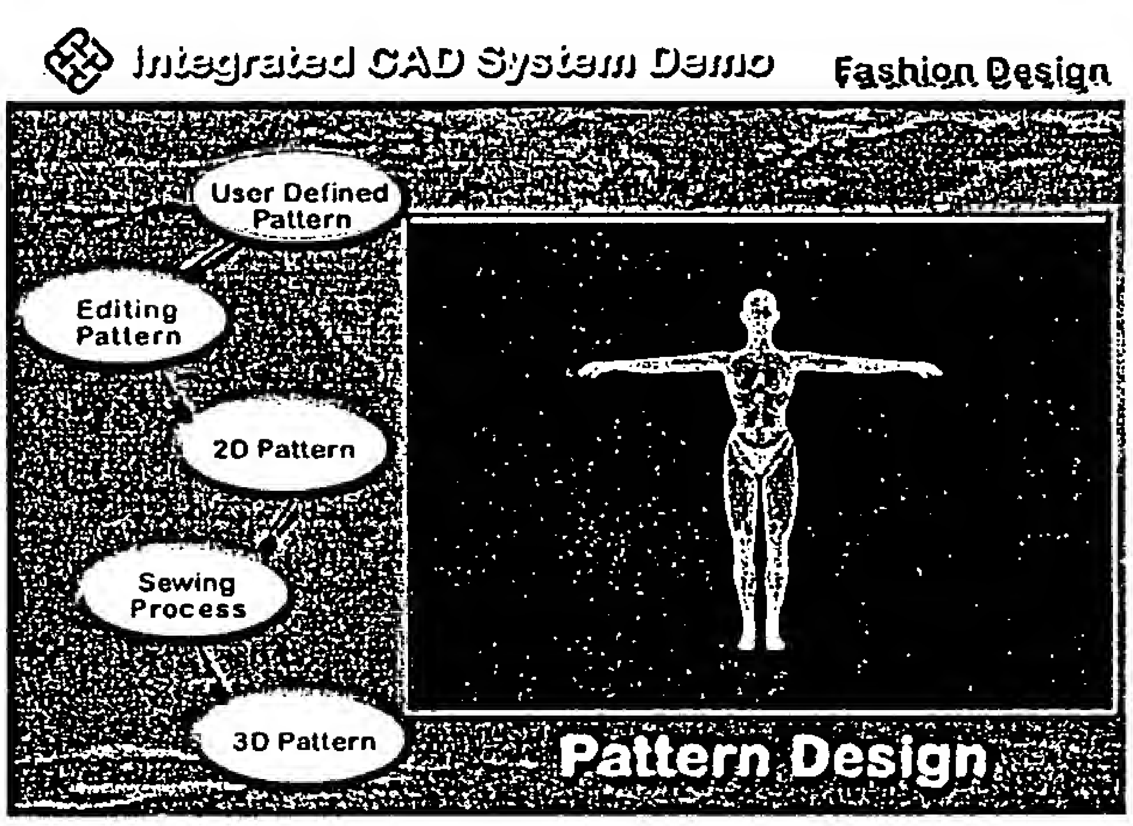

Figure 3 3D CAD technology for fashion design

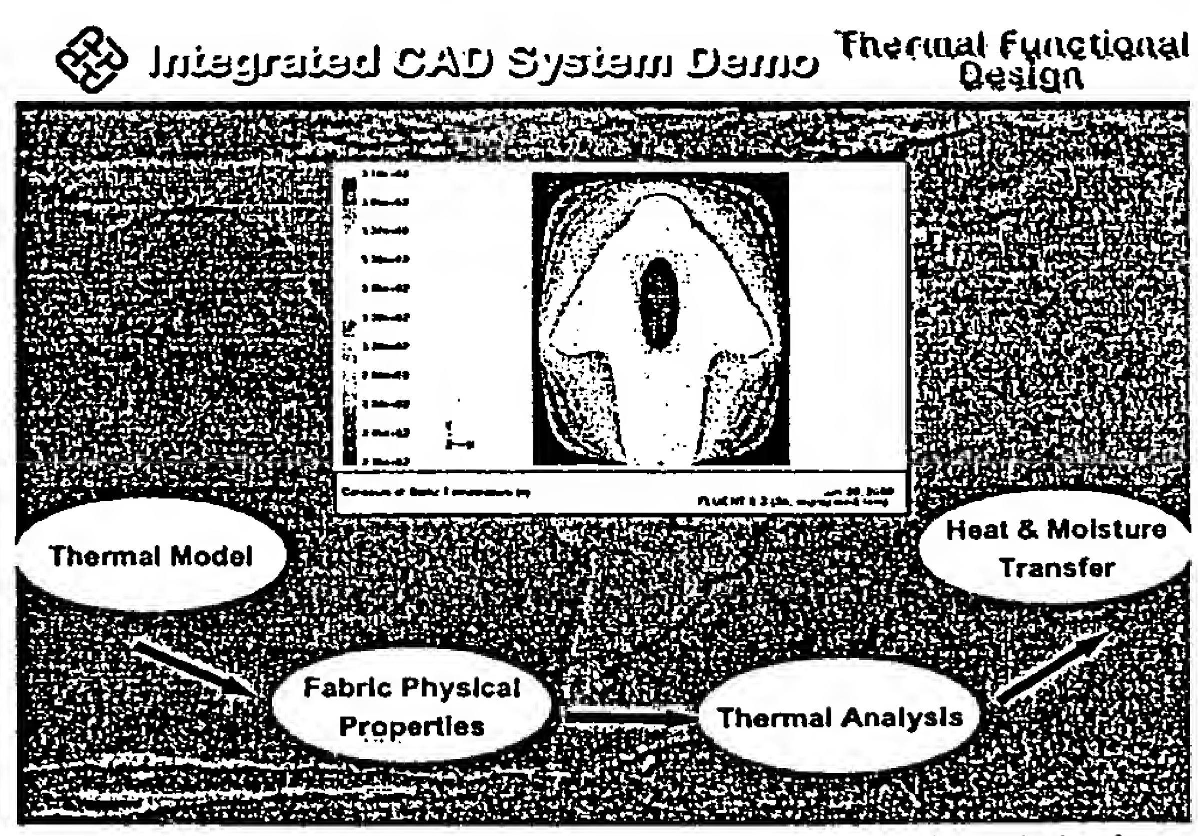

Figure 4 CAD technology for thermal functional design

The effect of style and fit is related to body size and shape, 2D fabric cuttings and 3D wrapping to human body, as well as the mechanical behaviour of clothing materials. To simulate and visualize the 3D effect, we need measuring body size and generate 3D geometric body shape (i.e. body profiles and virtual manikin), on which 2D fabric cuttings determined by style and fit can be wrapped. By adding on the effects of colour, pattern, texture and drape, designers and/or consumers

are able to view the artistic and fashionable effect, as shown in Figure 3. Extensive R&D activities have been in both academic institutions and commercial organizations to develop such technology.

3. CAD for Thermal Functional Design

On the basis of the numerical geometric virtual manikin, a model simulating the thermoregulation of human body (i.e. numerical thermal human model) needs to be developed. The numerical thermal human model will be integrated with the model of heat and moisture transfer in clothing materials and in the external environment to simulate the heat and moisture generation and transfer processes of the body-clothing-environment system as the basis of thermal functional design, as shown in Figure 4.

Using such a numerical simulation system, we are able to investigate the influence of fibers, fabrics, clothing, the physical activities of the body and external environment on the thermal comfort and functional performance, as shown in Table 1. The mathematical models developed and improved by various researchers such as Henry (1939) and Farnworth (1986) to describe the complex coupled heat and moisture transfer in textiles have laid a sound scientific basis to achieve this goal. For instance, Li and Holcombe (1998) interfaced a fabric heat and moisture transfer model with Gagge's two-node thermo-regulatory model of the body to investigate the impact of fiber hygroscopicity on the dynamic thermoregulatory responses of the body during exercise and on protection of the body against rain.

Table 1 Input and Output variables in thermal functional design

Input variables	Output variables
• Fiber structural and properties, such as fiber diameter, fiber density, moisture sorption isotherm, heat of sorption, and water diffusion coefficient, specific heat; • Fabric structural and thermal properties, such as thickness, porosity, tortuosity, thermal conductivity and volumetric thermal capacity; • Skin thermal properties: thickness, thermal conductivity, water diffusion coefficient, volumetric thermal capacity; • Ambient boundary conditions: temperature, relative humidity and air velocity; • Style and fit of apparel products.	• profile of temperature in the fabric; • profile of moisture content of fibers; • profile of moisture in the air of the fabric void space; • profile of temperature at the skin surface; • the neurophysiological responses of thermal receptors in the skin; • Intensity of subjective perception of thermal and moisture sensations.

4. CAD for Mechanical Functional Design

On the basis of the numerical geometric human model, a model simulating the biomechanical behaviour of human body (i.e. numerical mechanical human model) needs to be developed. The numerical mechanical human model will be integrated with the model of fabric mechanics to simulate the dynamic mechanical interactions between the body and clothing. Using such clothed numerical mechanical human model, similar to thermal function design, we are able to study the effect of structural and mechanical properties of fibers, yarns and fabrics, and clothing style and fit on the mechanical comfort and functional performance of apparel products (Figure 5). The extensive research on modeling fabric mechanics in the last century has laid down a sound scientific knowledge foundation to achieve this aim. For example, Zhang and Li et al (1999) studied the physical mechanisms of woven fabric bagging and developed mathematical simulation of fabric bagging behavior. During bagging, fabrics are exposed to sophisticated multi-dimensional

deformation inserted by the contact force from human body parts such as the knees. The understanding of physical mechanisms and modeling methodology of fabric bagging can be applied to simulate the mechanical behavior of garments and mechanical comfort of the wearer by modifying the boundary conditions and specifying different fiber mechanical properties and fabric structural characteristics.

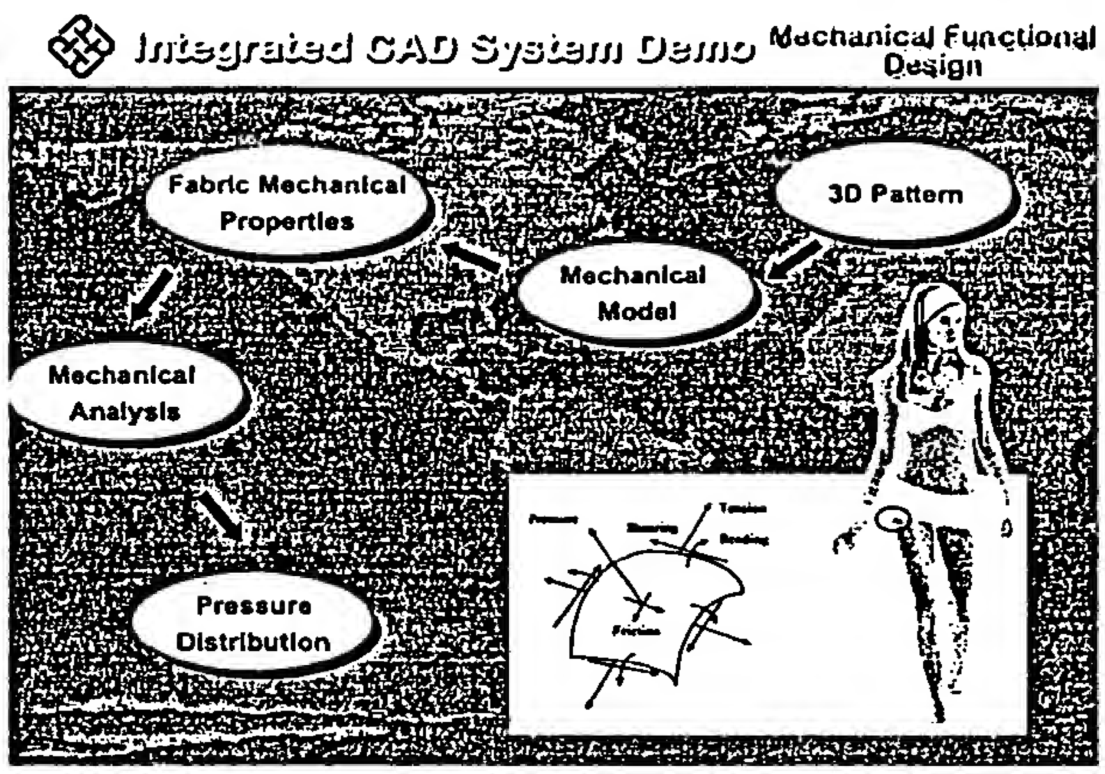

Figure 5 CAD technology for mechanical functional design

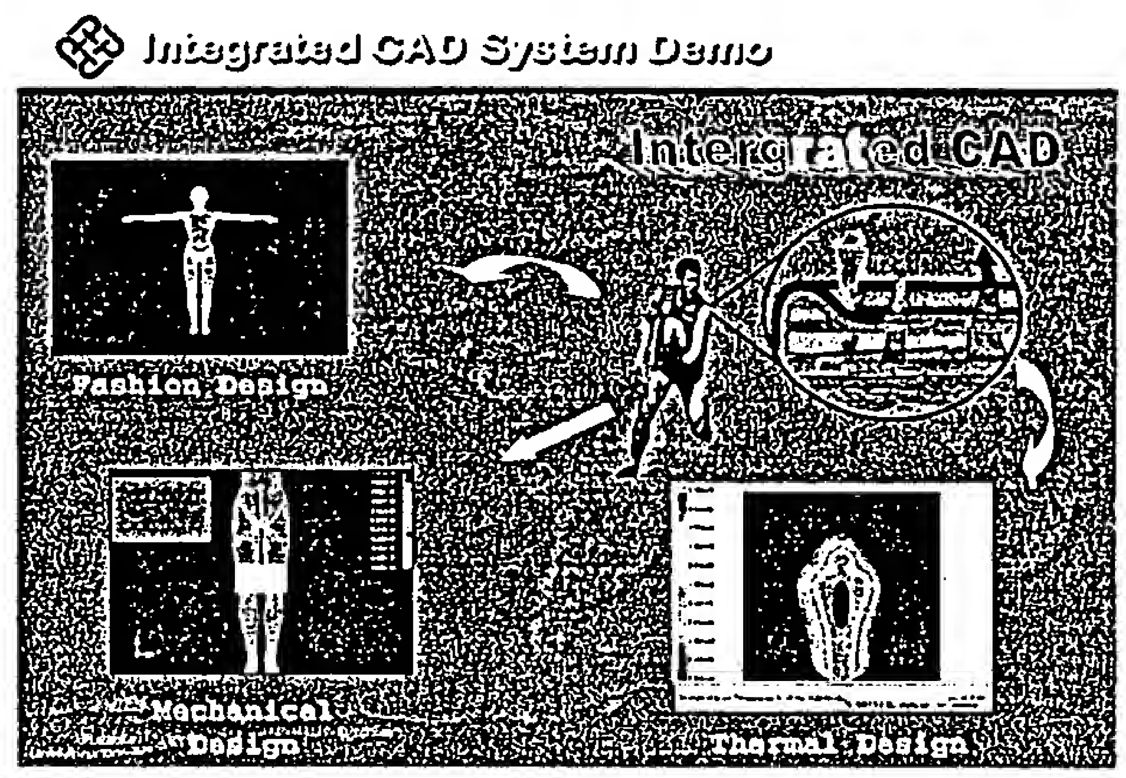

Figure 6 Integrated CAD technology for design of functional apparel products

5. Integrated CAD Technology

The fundamental research in modeling and simulating the heat and moisture in textiles and fabric mechanics has establish a good foundation to develop advanced computing technology for integrated design, which is able to introduce science into the apparel design process. By integrating the computing technologies for fashion design, thermal functional design and mechanical functional design, we are able to reveal the outlook, the comfort and functional of clothing before it is actually made, as shown in Figure 6. Using the mathematical models with advanced computational techniques, we are able to simulate the dynamic heat and moisture transfer processes from the human body and clothing to the environment, and the dynamic mechanical interaction between the body and clothing. The simulation results can be visualized and characterized to show the dynamic temperature and moisture distribution profiles in human body, clothing and environment and stress distributions in clothing and on the body. Thus, we are able to demonstrate how changes in physical activities, environmental conditions and/or different design of clothing will influence the thermal and mechanical comfort of the wearer. Therefore, on the basis of the scientific mathematical models we can develop integrated computing aided design technologies that are workable as advanced engineering design tool for textile and clothing industry.

Acknowledgement

We would like to thank The Hong Kong Polytechnic University for the funding of this research through the Area of Strategic Development in Apparel Product Development and Marketing.

Reference:

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